

# The Surgeon and the Smartphone - is the Association Really Smart?

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## Abstract

The aim of this literature review is to encompass the importance of integrating smartphones in the life of a surgeon especially in the era of the COVID-19 pandemic. With the progression of technology, telesurgery, remote pre and postoperative care, smartphone-assisted intraoperative navigation and transcontinental education can be made a reality. Nonetheless, rates of nosocomial infections have been raised and the increased use of a smartphone can compound this issue. Similarly, there is a greater potential for operator distraction, medical equipment interference and increased radiation exposure for the user. All the above create a new set of problems for the surgeon. We hereby attempt a review of the advantages and harmful effects from the usage of smartphones.

**Key words:** Surgeon; smartphone; intraoperative, mobile Health; telemedicine; health care-associated infections

## Introduction

Technology has been progressing at a blistering pace over the last three decades. The improvement in technology has affected all spheres of life, from virtual assistant artificial intelligence home devices such as Alexa and Google assistant to the work on nanoparticle neural networks. The surgical community is no exception to this; there have been boundless advances in all fields of surgery – starting with technological advances in simple smartphones to Tele-robotics. Smartphones, especially, have undergone intricate changes with the advent of nanotechnology, and can virtually do everything that a personal computer does, something that was inconceivable almost two decades ago. Smartphone integration with the operation theatre has the potential to streamline workflow, make preoperative and intraoperative planning and navigation more stringent. Likewise, enables trainees to better visualise, assimilate and understand what their senior surgeons are performing [1,2]. This review article aims to give the reader an overview of the various pros and cons that smartphone integration with the operative theatre may provide. This field is upcoming and termed mobile health (mHealth) [3]

with more than 40,000 applications already available and countless more under development.

## Use of smartphones by surgeons

### 1. Telemedicine

World Health Organization has defined Telemedicine as the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities [4]. The ambitious goal of telemedicine is to eliminate the need of physical presence of both the doctor and the patient in the same location, thereby providing access to healthcare and specialists in remote parts of the world and simultaneously eliminating the need to travel. This also effectively removes barriers to access to healthcare especially in developing areas, remote areas, war-torn areas and in natural disasters where access is limited or dangerous [5]. In the COVID-19 era this is more than significant. A number of applications of the use of Telemedicine are given as follows.

**Tele-robotics and Tele-surgery:** There has been tremendous growth in the field of Telesurgery in the past few decades. Teleoperated medical robotic systems utilise wired or wireless communication networks to conduct procedures and aid in diagnosis. By eliminating the need for physical contact between the surgeon and the patient, there is also less risk of transmission of infectious

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diseases. Robotic systems were first introduced in the mid-80s. The first successful telesurgery with the name "Operation Lindbergh", was a laparoscopic cholecystectomy performed in 2001 by a team of French surgeons in New York operating on a 68 year old female patient in France by using the Zeus Operating System [6].

There are short and long-distance tele-robotic systems - mainly of the Master and Slave type where the remote manipulator is controlled by the operator site by sending position commands. The former receives visual and other sensory feedback information. Short-distance systems include the da Vinci telerobotic system where the operator site is alongside the patient but separated from the robotic unit. Long-distance systems include telerobotic systems that are geographically separated, with the link between them being an existing communication infrastructure via dedicated wire or wireless networks [7]. However, the underlying framework for telerobotics is telepresence - which requires that the information from the remote environment is relayed in a natural fashion to the receiver [8]. Ophthalmic surgeons have attempted to improve telepresence by using a smartphone as a device to attain stereoscopic vision for microsurgeries [9].

*Tele-mentoring:* One way of applying tele-mentoring is by the use of the smart phone screen. In this case, the smart phone screen is "mirrored" to a larger screen with the more experienced surgeon being given remote access to the said phone, and thus can guide the operating surgeon by means of a laser pointer [10].

*Teleradiology:* Teleradiology has already been well established with PACs (Picture Archiving and Communication System) workstations being remotely accessed intercontinentally. With sophistication in technology, portable DICOM (Digital Imaging and Communication in Medicine) viewers in smart phones allow intra-operative collaboration of surgeons and radiologists with correlation of real time intraoperative images and their radiologic counterparts be it, USG, radiographs, CT or MRI scroll stacks. Teleradiology can also be used effectively in facilitating the diagnosis of many clinical situations such as in acute appendicitis [11].

*Telediagnosis:* Plastic surgeons, especially, have utilized applications in free-flap assessment both intra-operatively and post-operatively with serial images. Portable USG machines can be wirelessly connected to the smartphones for doppler assessments of the flap pedicles as well [12]. Applications in Day Care surgery include sharing post-operative wound images of patients via smart phone to the operating surgeons -this has shown to reduce the number of unnecessary hospital visits [13,14]. In India, due to the Coronavirus pandemic, The Ministry of Health

and Family Welfare has made initiatives to provide online teleservices in replacement of non-functioning out-patient clinics [15]. This flagship service offered by the government serves as a valuable means of reducing unnecessary office visits by providing easier access to healthcare. The disadvantage of course is that the patient should own a smartphone and should have good internet connectivity which might not be feasible for everyone, particularly in rural India.

*Telerounding:* Telerounding is of paramount importance for senior surgeons, especially in the era of COVID-19.

## 2. Preoperative and postoperative care:

Smartphones can greatly improve immediate pre and post-operative care by improving communication and mass sharing of information. Studies have shown that approximately fifty percent of the time, operations have delays, with the primary remediable cause being miscommunication between the surgical, anesthetic and nursing teams [16]. A previous study demonstrated that there is an increase in team communication, delivery of healthcare and reduction in time between surgeries by providing various members of surgical-anaesthetic and nursing teams with smartphones [17]. Senior surgeons can also communicate specific instrument requests or last-minute changes/ requests to the team and reduce wastage of time.

Smartphones can also provide simple solutions of postoperative surveillance for attending surgeons who have limited post-operative contact with the patient. Many physical parameters of the patients' status such as operative site status, capillary refill, blanching versus non-blanching erythema or ventilatory settings can be assessed via video-calling thus reducing the number of unnecessary visits to the hospital [16].

## 3. Operative navigation and planning

Urology trainees also use navigation guided apps to aid in percutaneous nephrolithotomy approaches and reduce on table radiation exposure [18]. Central venous catheter placements and external drain placements that require fine needle angle adjustment have benefited from real time rendering of the underlying anatomic structures and accelerometers in built to help adjust and guide the needle angles. Thoracic surgeons performing segmentectomies can benefit from real time visual intraoperative anatomic rendering and superposition with already acquired CT or MRI DICOM images stored in PACS preoperatively [19].

## 4. Surgical education and Training

Paramount to a surgeon is developing and practicing new

skills. Instructive videos such as chest tube insertion, representative of 'just-in-time' learning or cognitive rehearsal models, have shown to be of great benefit just prior to interventions. There are also a multitude of medical applications that significantly aid in the education of surgeons. Firstly, applications that provide a user-friendly reading interface provide students and trainees to read otherwise hefty textbooks from their smartphones or tablets. Secondly, training applications such as Touch Surgery help to augment surgical performance by providing accurate simulations to prepare and test themselves on common surgical procedures. There are also a multitude of other applications, such as iNotebook, that provide surgeons to keep a log of their cases complete with intraoperative photographs and intraoperative notes. There are also a wide variety of applications for anatomy, surgical dissections, examination training applications and so forth. The possibilities for mobile phone applications are limitless [20]. Lastly, due to the Coronavirus pandemic, face-to-face teaching seminars and classes have been suspended worldwide; video-meet applications such as Google meet and Zoom have facilitated resumption of classes and seminars as well as meetings, thereby helping with continuance of medical education and administrative work which would otherwise not be possible.

## 5. Communication

With the advent of applications such as WhatsApp and Facetime, communication has greatly improved. WhatsApp groups can be made for separate teams for mass communication of notices and guidelines, for updating patients' progress or for any enquiries.

## 6. Medical Imaging and Photographic documentation

With the advent of smartphone lens technology, surgeons can easily document intraoperative photographs, radiological cases and clinical entities for academic or research purposes. The relatively inexpensive smartphone is more readily accessible and easy to use compared to the DSLR (Digital Single-Lens Reflex camera) camera thus making documentation easier and more regular.

## Concerns with use of smartphones

### 1. Health care associated infections

Multiple studies have been done to demonstrate the association between use of white coats and incidence of hospital acquired infections. However, smartphones and mobile phones are used extensively by health care professions and are arguably a more common source of infection as compared to white coats in the current era. According to the Centre for Disease Control, Mobile

phones are one of the most commonly touched surfaces along with counters, tabletops, doorknobs, bathroom fixtures, toilets, keyboards, tablets and bedside tables. Mobile phones are a particular 'high risk' surface as they can come in direct contact with the face or mouth while talking over the phone, even if hands are properly washed and clean. Since they are neither disposable nor washable, disinfection is difficult. Literature review has shown that contamination rates vary from 40% to as high as 60%. The most frequent bacteria encountered are Staphylococcus (10-90%) and most are methicillin-resistant. In one study, 10% of phones were positive for viral pathogens. Surprisingly, studies have also shown medical students to have four times higher odds of having heavy microbial growth on their phones [2]. Considering this, the usage of mobile phones can pose a high risk of contamination of the sterile operation theatre.

### 2. Distraction

Smartphones are a huge distraction, especially in the operating theatre, not only for the operating team but for the anaesthesia team and circulatory staff as well. Studies have shown that the self-reported use of mobile phones among health workers ranges from once every 15 minutes to once every 2 hours [21]. Nomophobia, refers to discomfort, anxiety, nervousness or anguish caused by being out of contact with a mobile phone or computer [22]. This has become a significant problem even amongst medical field personnel and significantly increasing the level of distraction. A study done on functional magnetic imaging has shown that during learning without distractions, the hippocampus is involved in the processing and sharing of information. However, while multitasking, hippocampus is not involved; the striatum instead, which supports habitual task performance, is engaged. Hence, creative and adaptive problem solving and flexibility will be less likely. Thus, there will be a longer reaction time as the situational awareness will be decreased, with a diminished ability to identify and respond to hazards. A 'sterile cockpit' environment similar to what pilots use should be adopted at least during the critical steps of the operation. Simulation studies have shown that if distractors are present, performance declines maximally in laparoscopic surgeries followed by robotic and open surgeries. Consideration should also be made for the noise pollution caused by the constant ringing of the smartphones, especially during the critical steps of the operation [23-25].

### 3. Interference with medical equipment

At present, there are no fixed guidelines or regulations

on the use of smartphones near medical equipment in operating theatres or in the wards. The safest option is Irnich and Tobisch “one meter rule” which entails restriction of the use of phones less than 1 meter from medical equipment [26]. Most interference is in relation to the disturbance of the cardiac monitor signals [27]. However, with technological advancement, studies have shown that newer equipment has become less sensitive to interference from external sources [25].

#### 4. Radiation exposure

Multiple studies have been done to ascertain the risk of radiation exposure associated with the use of mobile phones. One such study showed that the use of cell phones for more than 50 minutes a day could be associated with early dementia [28]. In 2011, the International Agency for Research on Cancer (IARC) determined that Radio Frequency Radiation (RFR) emitted by cell phones belongs to Group 2B (“possible”) human carcinogen [29]. Current knowledge shows that there is ample justification to warn the general public that having a cell phone in close proximity is harmful [30]. Thus, surgeons are no exception to the same recommendations and should try to minimize unnecessary use.

#### 5. Effect on body

Users of smartphones commonly maintain their necks at approximately 45 degrees of flexion. This causes an alarming level of strain on the cervical spine. In the neutral position, the head weighs a relative 10-12 lbs as compared to 27lbs, 40lbs, 49lbs and 60 lbs at 15 degrees, 30 degrees, 45 degrees and 60 degrees respectively [31]. This causes serious musculoskeletal consequences. Longitudinal studies have also shown that there is a relation with time spent texting and persistent neck and upper back pain. Thus, physicians and the general public should be aware of the potential strain on the spine by the use of smartphones and take appropriate measures such as posture adjustment to avoid ‘text neck’ and other detrimental effects [32].

#### 6. Loss of personal touch

In spite of all the advantages of using a smartphone, there is definitely a lack of personal touch when using a smartphone for communication, especially with regards to patient care. The general lack of eye contact and face to face communication all adds to the perception of detachment. One possible way to mitigate this is to use video calls more often and be more expressive while texting.

#### 7. Compromise to patient’s privacy

One of the major concerns with the use of smartphones

in relation to patient care is protection of the patient’s health information. Prior to giving permission of the use of smartphones for storage of personal healthcare information, security threats must be thoroughly assessed. For instance, in the European Union, the General Data Protection Regulation (GDPR), which was enforced from May 25, 2018 onwards, was a landmark in the evolution of European privacy framework with implications globally. GDPR regulations that are healthcare-related include any patient data pertaining to the patient’s health, genetic data or biometric data. Hospitals and other healthcare institutions will need to adopt stringent guidelines including increased transparency, faster responses to patients’ access requests and incorporate the GDPR framework such as an additional data protection impact assessment (DPIA) at the time of the patient consent. Under GDPR the stipulation of the ‘right to be forgotten’ entails patients having the right to ask healthcare organisations to completely delete their records under certain conditions. Thus, hospitals have to be prepared for this situation. Non compliance with GDPR regulations can result in fines of up to 20 million Euros or 4 percent of the annual turnover whichever greater. Thus, with the usage of smartphones and other devices, GDPR regulations must be strictly adhered to, as even an inadvertent breach would have dire financial consequences for the treating hospital [33].

### Conclusion

Mobile Health (mHealth) is the future of the operating surgeon, especially in the current and post-coronavirus pandemic era where remote access is paramount to the daily duties of the surgeon. A general change in perspective is needed to herald in the era of the digital age. Similar to art galleries being digitised and museums uploaded into three-dimensional art, telesurgery and tele-robotics may soon be the norm rather than the exception. There are many other long-term and short-term benefits of mHealth, including better access to education and training, communication, intraoperative assistance and documentation. Concerns with the use of smart devices include spread of infectious diseases, source of distraction, radiation, potential strain on the body due to improper posture. These can be mitigated by proper education, government policies and phone hygiene.

**Conflict of Interest:** The authors declare that they have no conflict of interest.

**Ethical Approval:** All India Institute of Medical Sciences, Rishikesh does not require ethical approval for reporting review articles.

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